INTELLIGENT V2G SYSTEM FOR EV CHARGING STATION POWERED BY SOLAR AND GRID

SYNOPSIS

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1. INTRODUCTION

Greenhouse gases have a significant impact on our planet, and one way to reduce them is by switching from conventional internal combustion engines to electrical ones. Today, all nations and businesses around the world are moving toward switching to electrical vehicles. Governments are providing significant financial support, and businesses are setting deadlines for making the full transition from conventional to electrical vehicles. Electric vehicles are environmentally friendly since they produce no emissions and nearly little noise. [1] Since renewable energy sources may be deployed anywhere, switching from conventional to electrical vehicles will result in an increase in the demand for electricity. To address this issue, we must use renewable energy sources. By using renewable energy sources, such as solar, wind, and other types, we also consume less fossil fuel, which reduces greenhouse gas emissions. It can be put in place at home or in a business's parking lot where cars are frequently parked. [2] Regarding our suggested solution, we decided to employ photovoltaic technology because it can be used in tiny areas like dwellings and Saudi Arabia's weather is sunny for the majority of the year. Using a buck converter to charge the electric vehicle, a bidirectional converter to charge and discharge the storage batteries, and a boost converter to power the station from the PV panels. [3] Nowadays, all nations are working to cut their CO2 emissions when producing electricity. The energy system based on coal is mostly to blame for the excessive CO2 emissions. Most people are now interested in converting their gasoline-powered vehicles to electric vehicles. Use PV cells, a form of renewable energy, to create electricity in charging stations in order to resolve the problem. Numerous EVs raise the demand on power networks, harming the environment and compromising the stability of power systems. [4] The DC bus is directly connected upstream to a charging station. It might contain one or more charging cables with nozzle connectors similar to those found on gas station pumps that are used to deliver electricity into the vehicle in the same way: The lithium-ion battery is readily charged by connecting to the EVs. The station contains LEDs that indicate whether the station panel is in the charging or discharging mode, with the colors green or red, respectively. An electronic payment system, card-controlled access system, energy meter, and Internet connection are just a few additional features that are possible.[5] All charging stations have an earth fault detector built in for safety to lessen the risk. End users can never handle risky voltages or currents.

Furthermore, When an EV charging socket is properly installed and communication has been established between the car and the charging station, only then are connection pins in a cable energized. The connector is additionally totally shielded from the elements. Finally, a mechanical lock (latch) guards against unintentional disconnections brought on by a forceful pull on the cable. [6] Due to global warming and the potential extinction of fossil fuels in the coming decades, more and more people are switching to electric cars (EV) instead of vehicles that rely on internal combustion engines (ICE). However, additional loads will also be applied to the grid system at the same time. The use of renewable energy especially Electric vehicle (EV) charging is best done with photovoltaic (PV) electricity, which is widely available during office hours [7]. If charging facilities predominantly rely on grid electricity, which is often produced from unfriendly sources like fossil fuels, the assumption that the EV is an environmentally benign vehicle may not be accepted. [8].

2. LITERATURE SURVEY

1. Title: "Bidirectional Power Flow Control of Solar PV Array-Based Multifunctional E- Mobility Charger "

Author: Saurabh Shukla, Al-Durra, El-Fouly, T.H. and El-Saadany (2020)

Description: Electric vehicle (EV) charger that uses a solar photovoltaic bidirectional power flow to correct reactive power. In this configuration, a solar PV system simultaneously charges the storage batteries for electric vehicles and feeds the remaining electricity to the grid as a basis for bidirectional power flow. [9]

2. Title: "Solar EV Chargers and Super Flow Batteries for an Efficient Electric Vehicle" Author: Paarth Gupta (2020)

Description: Solar power is a renewable energy source that is unrestricted, clean, cost-free, and safe for the environment. It is therefore extremely effective and does not harm the environment. The question at hand is whether or not electric cars and other forms of mobility are environmentally friendly. [10].

3. Title: "A 10kW Solar-Powered Bidirectional EV Charger Compatible with Chademo and COMBO" Author: Ram Chandra Mouli (2018)

Description: Photovoltaic generation is defined by both diurnal and seasonal variations. Since

photovoltaic (PV) panels may be installed on building rooftops and parking lots, factories and industrial zones make suitable locations for solar EV charging. This requires a grid connection to ensure a reliable power source for charging the EVs. Solar energy may be used to charge electric vehicles in a variety of ways. [11].

4. Title: “Evaluation of Topology for a Solar Powered Bidirectional Electric Vehicle Charge”

Author: Albert Bassa de los Mozos, Gautham Ram Chandra Mouli (2014)

Description: Since their exhaust pipes don't generate any pollutants, electric vehicles (EVs) are regarded as clean modes of transportation. The electrical grids in most nations are also primarily powered by fossil fuels. Therefore, even if EVs are charged from such a grid, net emissions will still be present. A truly sustainable solution for charging EVs is to use electricity from photovoltaic (PV) panels or wind turbines. An electric vehicle solar charging station at a building with PV panels [12].

5.Title: “Photovoltaic EV Charge Station”

Author: Peter Kadar A.Varga (2013)

Description: Currently, the creation of electric vehicles is a hot topic. We are dealing with an energetic element with the delivery of the EV charger. The batteries in electric cars need to be charged and recharged frequently. There are numerous options being considered. High Frequency Wireless Power [13].

6. Title: “Mitigation of Solar Irradiance Intermittency in Photovoltaic Power Systems With Integrated Electric-Vehicle Charging Functionality”

Author: Joshua Traube (2015)

Description: The electrification of transportation and the increase in gasoline prices. Nonetheless, especially in areas with a lot of passing clouds, are very unpredictable in their output power. Utilization and power conversion industries are ready for grid infrastructure issues brought on by a rise in renewable energy sources, such as those caused by rapid, significant changes in a photovoltaic system's output power. [14].

7. Title: “Comparison of System Architecture and Converter Topology for a Solar Powered Electric Vehicle Charging Station”

Author: G.R. Mouli, P. Bauer and Zeman M (2015)

Description: The long-term option for recharging automotive batteries is solar-powered electric vehicle (EV) charging. locations near factories, office buildings, and industrial areas are ideal for solar EV charging since photovoltaic (PV) panels can be installed on building rooftops and in parking lots. [15].

8. Title: “Power-Loss Analysis and Efficiency Maximization of A Silicon-Carbide MOSFET Based Three-phase 10kW Bi-directional EV Charger Using Variable-DC-Bus Control”

Author: Xuntuo Wang (2016)

Description: To promote the use of EVs, a practical, high-efficiency, and high-power charging infrastructure is necessary. To adopt Vehicle to Grid (V2G) and Grid to Vehicle (G2V) technologies, the power grid also needs to have a high-efficiency bi-directional charger. The primary components of an electric vehicle (EV) battery charging system are a bidirectional Power Factor Control (PFC) rectifier, a bidirectional isolated DC/DC converter, and a unidirectional DC/DC converter for solar panels (if renewable energy is employed). [16].

9. Title: “Implementation of Solar PV-Battery and Diesel Generator Based Electric Vehicle Charging Station.

Author: Bhim Singh (2020)

Description: PV fed grid connected system, along with Battery energy storage system (BES), grid relied electric vehicle charging station and a diesel generator, for providing incessant charging in grid connected, islanded and in DG set connected modes. The design is mainly based on the PV system along with BES, using which the Electric vehicles are charged. Beneath all operating conditions, the generator set draws specific power and operates with 85 percent loading condition, in order to attain maximum fuel efficiency. Excluding any mechanical speed governor, the charging station controls the frequency and the generator voltage. The defined technique assist in Vehicle to home, Vehicle to Vehicle and Vehicle to grid reactive /active power transfer, so as to enhance the operating efficiency of charging station. However, improvised tracking techniques have to be used for monitoring the state of charge of the battery, so as to prevent overcharging of the battery [17].

10.Title: Experimental Validation of a Three-Port Integrated Topology to Interface Electric Vehicles and Renewables With the Electrical Grid.

Author:Vitor Montiero J. G. Pinto and J. L. Afonso, et al (2018)

Study on the experimental evaluation and analysis about the Off-board three port integrated topology, which aids interfacing electric vehicles with solar systems and the grid. With the assistance of Renewable to vehicle operating mode, the energy from the solar system charges the batteries of electric vehicle. By reconfiguring the operating modes, it is probable to develop novel combined operating modes. In the defined work, for controlling the dc and ac side currents of the integrated topology, a current control strategy is employed, along with a power theory. This technique aids in better THD reduction at all operating modes and also reduces the number of stages involved in the power conversion. Moreover, using novel converters, it is further possible to reduce the conversion stages [18].

11.Title : Hybrid Optimization for Economic Deployment of ESS in PV-Integrated EV Charging Stations.

Author: Kalpesh Chaudhari Ukil, K. N. Kumar, U. Manandhar and S. K. Kollimalla, et al (2018)

Hybrid optimization algorithm based energy management system. This technique transfers its mode of operation amid rule based and deterministic technique, based on the electricity cost band allocation. For electric vehicle charging applications, a cost degradation model of energy storage system, along with solar power with reduced cost are employed. The defined technique employs an algorithm that involves three stages namely classification of real time electricity cost, with respect to various price bands, computation of solar power in real time based on the data attained from solar irradiation and the reduction in operating cost of the electric vehicle charging station, combined with the ESS and the solar system. Nevertheless, in case of multiple charging stations, extra stages with optimization methods are necessary for energy transfer amid the solar and the storage systems [19].

3. MOTIVATION

1. Electric vehicles (EVs) are seen as the transportation of the future. Compared to gasoline and diesel powered vehicles, EVs are significantly more energy efficient and emit no carbon dioxide. They are substantially less noisy, have a lot simpler drive train, and require very little maintenance. However, electric vehicles (EVs) may only be considered sustainable if the electricity needed to charge them originates from renewable resources rather than fossil fuel-based power plants [20]–[22]. When

electric vehicles are charged from a system that is primarily powered by renewable energy, the net emissions are almost nil. In light of this difficulty, geothermal, biogas, or tidal energy are good sources of renewable energy that could one day be used to power electric vehicles. The use of solar photovoltaic panels to charge EVs is one of these, and it is appealing for a number of reasons.

2. Renewable energy sources have become crucial for meeting our daily energy needs as a result of the limited supply of petroleum. This project aims to provide a practical, cost-effective, and efficient model of a PV-based EV charging station. This study demonstrates that solar-powered EV charging stations may be implemented and sold without a grid connection.

3. The advantages of EVs and the requirement to support EV drivers will simulate the setup and use of EV charging stations in commercial and industrial power systems.

4. Typically, an on-board unidirectional charger, which is a component of the vehicle itself and only permits the charging of EV batteries via a flow of electricity from the grid, is used with EVs. This type of operation is known as unidirectional Grid to Vehicle (G2V) operation. But the relatively new idea of "V2G" operating, in which an electric vehicle with stored energy may export its power back to the electrical grid, provides the multiple advantages listed above and is quite realistic given that the vehicle remains parked for 85% of the time.

5. An effective way to address the intermittent issues with renewable resources is to charge from them during active hours and then feed this energy back during inactive hours.

6. By balancing the local Var demand of the load, reactive power support (V2G) reduces losses of reactive power long-span transmission in grids

4. GENERAL DESCRIPTION OF THE PROPOSED PROBLEM

The increased demand for power in commercial buildings is a global issue that affects many nations (Shaahid and Elhadidy, 2007; Pérez-Lombard, Ortiz, and Pout, 2008; Liu, Pistikopoulos, and Li, 2010; Chung and Rhee, 2014). Commercial structures include those used for education, hospitals, hotels, shopping centres, offices, restaurants, and retail stores. 13.37% of South Africa's overall power usage is made up of both the public and commercial sectors. The USA accounts for 28.5% of the world's electricity use in commercial buildings. According to PerezLombard, Ortiz, and Pout (2008), the business sector uses 11% and 18% of the total energy in the UK and the US, respectively. In affluent

nations, the energy consumption of residential and commercial buildings has continuously risen to between 20% and 40%. The amount of electricity used in university buildings is very high (Chung and Rhee, 2014). A major global problem has been matching the grid's electrical energy supply and demand in real time (Bajpai and Dash, 2012; Vadabhat and Banerjee, 2014; Aghajani, Shayanfar and Shayeghi, 2017). The deteriorating infrastructure on the supply side is the main cause of this issue (Gelazanskas and Gamage, 2014; Mahmood et al., 2014; Giglmayr et al., 2015). There are numerous factors that contribute to the issue on the demand side. First, there is the rising demand (Erdinc and Uzunoglu, 2012; Wu and Xia, 2015; Khare, Nema and Baredar, 2016). In South Africa, load shedding and power outages occurred in 2007 and 2008 as a result of the country's rising energy consumption. The electrical energy consumption of large buildings is the second factor (Pérez-Lombard, Ortiz, and Pout, 2008; Allab et al., 2017). The varying demand throughout the day is the third factor (Abdulaal and Asfour, 2016).

In order to meet these problems, consumers must adjust their energy usage (Lindberg et al., 2014) to the available generated power, help preserve the integrity of the electricity grid, and cut their electricity costs. Commercial users require a system that enables them to reduce the amount of electricity they consume, which they purchase from the grid. Such a system must to take into account load shedding as well as rising demand, growing energy demand, and varying demand throughout the data.

5. RESEARCH GAPS FOUND

Based on the thorough literature survey the following research gaps are found-

1. Lack of Bi-directional power flow in previous proposed technologies.

2. Increased losses with increase in conversion stages.

3. Issue related to the power factor and total harmonic distortion while charging the EV from main grid supply.

4. Commercially available EV chargers are not bidirectional and hence do not offer the efficient vehicles to grid (V2G) performance.

5. If the load would continuously change it would get impossible to monitor performance of renewable energy conversion system and battery storage system for fluctuations to the power provided.

6. PROPOSED OBJECTIVES OF THE RESEARCH

OBJ 1: To enable faster adoption of electric vehicles in India by ensuring safe reliable, accessible and affordable charging infrastructure and eco-system.

OBJ 2: To encourage preparedness of electrical distribution system to adopt EV charging infrastructure. Ease of charging.

OBJ 3: To develop an electrical model and design a bidirectional DC/DC conversion system for PV EV charging applications

OBJ 4: To provide improved voltage gain by converter thereby meeting the voltage demand.

OBJ 5: To Verify the performance of controller (bidirectional convertor for EV charging and controlling DC-DC convertor for extracting peak power output).

7. PROPOSED METHODOLOGY

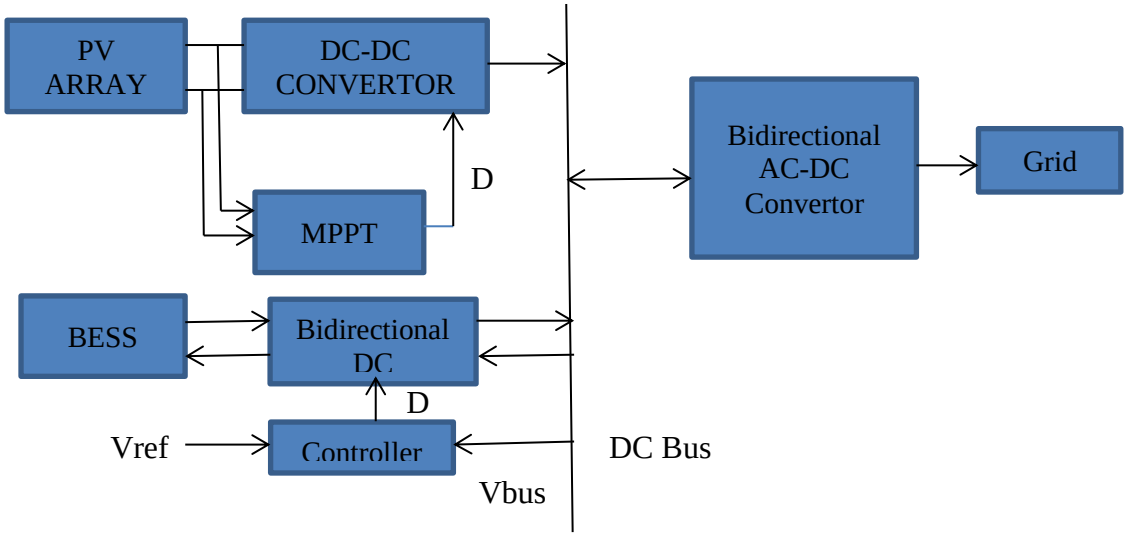

Fig.1 Flow Chart of the Proposed Methodology

Recently, the detrimental impacts of carbon emissions from fossil fuel powered vehicles on environment in the form of global warming and climate change has contributed to the popularity and appeal of EVs, which are emission free in nature. In order to promote the broad scale adoption of EVs, the development of an effective charging station is considered crucial. In this proposed system, a DC-DC converter configuration based EV charging station is modeled as shown in Figure 1, for ensuring quick and effective charging of the EV. The low unregulated dc voltage from the PV system is

transformed to stable output of required voltage level DC- DC converter. The modeled converter aids in achieving unity power factor in addition to minimized THD.Solar energy has been selected as the primary source of renewable energy for the off-grid electric vehicle charging station system. It is gathered by a PV array, which uses the sun's descending radiation to produce electricity for the electric vehicle charging station. But the energy produced is unsteady.

Due to environmental fluctuations and the fluctuating output power from intermittent solar cells, we construct energy storage systems that use batteries to store power during peak PV production and later when needed. To increase the voltage to the DC bus limit and aid in exploiting the maximum power point tracking (MPPT) condition of the PV panel, the output terminals of the PV are linked to a boost converter. Direct connection of a buck converter to a DC bus will step down the voltage. to charging EV battery (lithium-ion).Additionally, a bidirectional converter is used in two ways: first, as a buck converter to step down the voltage needed to charge the ESS battery (Lead-acid), and second, as a boost converter to step up the DC voltage needed to energize the bus and regulate the DC bus voltage in response to variations in the EV load and solar radiation level. The system successfully handles the irradiance's abrupt change while keeping the bus voltage constant.

Work needs to be expanded to include grid integration so that excess electricity may be sold to the grid and used when solar PV can't produce enough. In order to enhance revenue and the system's dependability during weekends and festivals, EV batteries can serve as a power source and sell any excess power generated to the grid.

8. TIMELINE FOR THE RESEARCH

Table 1: Task List (Year- I)

Period	Major Tasks
0-1 Month	Topic Finalization
1-3 Months	Collection of last 10 years articles from Elsevier, Springer, IEEE on my topic
3-4 Month	Frame the detailed sketch of the research gaps
4-4.5 Months	Problem Identification

Table 2: Task List (Year –II)

Period	Major Tasks
1-2 Month	Topic Finalization
0-1 Month	Establish the analysis of the existing works
1-3 month	Differentiate the existing methods and the necessity for development new model

3-4.5 Months	Analyze the achievements of the existing methods
4.5-5 Months	Propose a research solution

Table 3: Task List (Year-III)

Period	Major Tasks
5 - 6 Months	Learn about the implementation tool and implementation basics of energy efficient system.
6-9 Months	Implement the research solution to solve the challenges of the existing methods
9 - 10 Months	Implement the existing/comparative methods
10-10.5 Months	Analyze the performance of the proposed model based on the performance metrics
10.5-11 Months	Perform the comparative analysis of the existing methods with respect to the proposed model
11-12 Months	Establish the final achievement of the proposed model
0-1 Month	Documentation
6-12 Months	Publication process

9. SYNOPSIS SUMMARY

The proposed work to be carried out expected characteristics features-

1).Importance of solar energy in lowering worldwide CO2 emissions as well as the role played by the emergence of electric vehicles and the escalating demand for them globally.

2).To eliminate pollution from EV mobility (power generation using renewable resources).

3).To encourage EV users and owners/operators of charging stations to pay an affordable fee.

4). PVs will be added to and integrated into EV charging systems, reducing their reliance on the grid and boosting system flexibility

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